LETTERS TO THE EDITOR

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Misleading Applications of Familiar Scientific Terms.

May I, not as an expert in science, but as one who has made some research into the conditions of lucidity, venture to thank you for the protest which appears in your current number against a misleading application of the familiar term "Light"? This is not of course the only instance of the kind; but it seems especially regrettable as tending, by the very success and popularity of the Lectures reviewed, to introduce gratuitous confusion into youthful minds.

I may perhaps be pardoned for adding that I was fortunate enough in my little book, "Grains of Sense," published last year, to anticipate the verdict of your reviewer, and to point out how much, in this and similar cases, such modes of expression on the part of scientific men tend on the one hand to diminish our precious and too slender store of clearness of thought, and on the other to hinder the progress of science itself.

V. Welby.

April 1.

The Kinetic Theory and Radiant Energy.

In the course of the discussion which took place in your columns during the winter of 1894-5 on the kinetic theory of gases, emphasis was rightly laid on the difficulty of reconciling the law of partition of energy among the different degrees of freedom of molecules of gases with the large number of such degrees of freedom indicated by their spectra, and, generally, of explaining, on the kinetic theory, the relations between matter and the ether required to account for radiation. It was even suggested, by one writer, that the ether, with its vastly larger number of degrees of freedom, must ultimately absorb all the energy of the molecules. I instanced the case of a sphere moving in an infinite mass of perfect liquid as exemplifying a system where no such ultimate absorption of energy would take place, and pointed out that everything depended on the laws according to which transference of energy took place between the molecules and the ether.

The object of this letter is to show that the subsequent discovery of the Röntgen rays has suggested a theory of the radiation of heat which may possibly throw considerable light on the difficulties referred to by affording an answer to the question, "If the temperature of a gas is proportional to the mean translational kinetic energy of the molecules, how comes it that this kinetic energy can be transferred from one set of molecules to another by radiation through the ether?"

Consider the Röntgen rays: we know, firstly, that they are produced by the impact of the kathodic rays on the Crookes' tube, these latter consisting not improbably of streams of bombarding molecules; secondly, that they not only have the power of discharging electrified bodies, but also of modifying the electrical state of gases in such a way as to enable these to discharge bodies. In this modified air, to which Villari has applied the somewhat barbarous name of "aria Xata" or "xd. air," some kind of dissociation of the electrons must necessarily have taken place.

Arguing from analogy the idea suggests itself that the encounters between molecules of a gas, no less than the kathodic bombardments, may give rise to radiations, and these, too, when falling on another mass of gas may modify the electrical state of its molecules in such a way that their original electrical state is only restored by encounters between them.

Now taking, as a simple illustration, two oppositely electrified perfectly elastic conducting spheres; as these approach one another, they acquire kinetic energy in virtue of their attraction. On coming into contact they are discharged and the attraction ceases, so that their kinetic energy of separation is greater than that which they had previously to coming within each other's influence. Again, when a charged and an uncharged body impinge, the charge is distributed between them; they repel one another as they separate, and again acquire an increase of kinetic energy—as in the ordinargy pith-ball experiment.

It follows that the incidence of rays possessing the property suggested above will tend to increase the temperature of a gas.

The discharge which takes place at an encounter will, however, be an oscillatory one, and will lead, therefore, to further generation of undulatory rays.

Considering two masses of gas at unequal temperature, the impacts in the hotter gas, being the more frequent and violent, will give rise to the more copious emission of rays, and these falling on the cooler gas, will produce the greater electric dissociation resulting in the greater acquisition of kinetic energy in collisions between the molecules. The feebler rays from the colder gas will have less effect on the molecules of the hotter one, and the kinetic energy supplied in this way will not compensate for that lost by radiation. Thus the "theory of exchanges" will hold good.

A still more important consequence of such a theory is that no interaction will take place between the ether and molecules except where there are encounters between the latter, and, moreover, the interactions which occur in an isolated mass of gas will not affect the translational velocity of its centre of mass, nor the angular momenta about axes through its centre of mass. Thus it results that the celestial bodies go on in their course experiencing no resistance whatever from the ether.

On the other hand, the fact that light from distant stars is not absorbed before it reaches the earth, no longer implies the complete absence of matter in interstellar space. Isolated molecules will absorb no energy from the ether; and so long as the molecules moving about in interstellar space are assumed to be so few and far between that collisions practically never occur, there will be nothing to impede the passage of light or heat rays. It is only when such rays fall on assemblages of molecules sufficiently dense to possess the attributes of what we call *matter*—as, for example, when they reach our atmosphere—that absorption of energy will take place.

The phenomena of irreversibility and of degradation of energy would thus, so far as the present view goes, be restricted to material bodies, and hence the conditions necessary for the existence of life on our earth may have been brought about without the enormous waste of energy which would be required in the absence of *some* such theory.

A photo-voltaic theory of photographic action formed the subject of exhaustive experimental investigation at the hands of Herr Luggin last year, and photo-voltaic theories of vision have also been proposed. It would thus seem that the analogy between the action of heat rays, visible-light rays, ultra-violet rays and Röntgen rays may be complete. The question still remains, *how* are ethereal waves able to affect the electric state of assemblages of molecules? But since Röntgen-ray physicists have proved that they do this, the question has to be faced in any case. It is now rendered no more difficult, and, on the other hand, our theories of the relations between ether and matter are simplified by referring radiation of heat to the same phenomenon.

G. H. Bryan.

Note on Mr. Wood's Method of Illustrating Planetary Orbits.

I fear that Mr. Wood's beautiful method of illustrating planetary orbits by means of a bicycle ball rolling on a glass plate about the pole of an electro-magnet (Nature, April 29, 1897), has rather fallen into disrepute in the minds of many physicists since its criticism by Mr. Anderson in Nature, May 13, 1897. Mr. Anderson there states that the law of attraction in such a case would be that of the inverse fifth power of the distance. This could only be true if the ball were of very soft iron. A bicycle ball is far from this, and becomes strongly magnetised after brief use in the experiment, behaving like a permanent magnet of great coercive force. Under these conditions the attraction between the pole and the ball will vary approximately as the inverse third power. There is also another factor to be considered. If the true pole lies below the glass plate, only a certain component of the total force is active in producing the attraction towards the centre of motion. To determine what the law of variation of this component will be, I have had one of my students take a number of series of observations on the attraction of a bicycle ball along a plane perpendicular to the axis of a magnet.

In the experiments the magnet was horizontal, and the bicycle ball with its magnetic axis vertical was fastened to one end of a strip of spring brass, the other end of which was clamped fast in

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a sliding clamp so as to be raised and lowered. The bending of the brass strip under the attraction of the magnet on the ball was measured by means of a telescope and scale, the mirror being fastened to the end of the strip. As the motion of the ball was entirely in a plane perpendicular to the axis of the magnet, the law of variation of force must have been very nearly the same as in the orbit experiments.

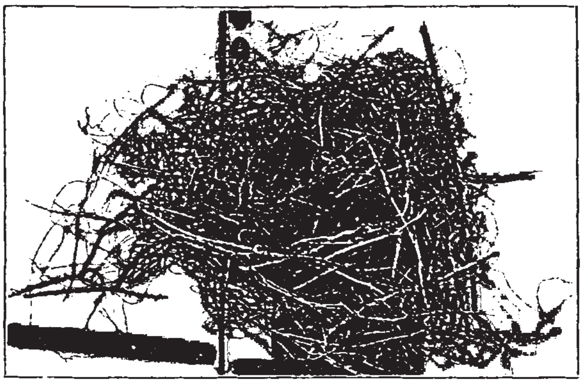
When the ball was directly over the true pole, which lay about 1 cm. from the end of the conical pole-piece, the law was nearly that of the inverse cube, the observations being taken between the limits of 3 cm. and 14 cm. from the axis of the magnet. Other series were taken with the plane of motion of the ball at different distances from the pole, and it was found that with the plane of motion at 2·8 cm. from the true pole the law of the inverse square was very closely obeyed between 4 cm. and 14 cm. from the axis. These limits cover the region in which the orbits would in most cases be formed. The exact law of force as determined by least squares from seven observations between the above limits was that of the 2·1 power of the distance.

Louis W. Austin.

The University of Wisconsin, Madison, Wis., March 16.

An Extraordinary Heron's Nest.

I send you a photograph of probably the most extraordinary heron's nest ever discovered in this or any other country. During a gale it was blown from the top of an elm tree in the heronry on Stoke Hall estate in Notts, the seat of Sir Henry Bromley, Bart. It is of unusual size, and almost exclusively composed of wire of varying lengths and thickness; the centre, or "cup," alone being composed of fine twigs, grasses and feathers. Several other nests of the heronry, which had also been blown down, contained pieces of wire cleverly worked in with twigs in the usual way, but this was the only one entirely composed of that material, as far as the main structure is concerned. There are happily now a very flourishing heronry at Dallam Tower, Westmorland, the seat of Sir Henry Bromley's son, Mr. Maurice Bromley-Wilson, and although I have been familiar with it "off and on" for very many years, and with several other heronries in various parts of the country, I never knew of the birds using wire in the construction of their nests. I have several records of rooks using wire in large quantities in the construction of their nests. Particulars of one very remarkable instance were published in the *Yorkshire Weekly Post* of May 19, 1894, and of another in the same paper for June 23, 1894. Both of these freaks took place in India: one at Calcutta, the other at Rangoon. The other curious feature of the Stoke Hall phenomenon is that there is, and never has been, any lack of ordinary building material, and that all the wire used must have been carried a great distance.



G. W. Murdoch.

Westmorland.

"The Story of Gloucester."

Referring to your article (p. 221), I think you cannot have looked at pages 70 to 117 of the Gloucester Small-pox Epidemic Blue Book, by Dr. Coupland. I have analysed all these cases, and here is the result.

Description.	Cases.	Deaths.	Deaths per cent. of cases.
"*Unvaccinated*"— These contain 21 cases, 10 deaths, whose description includes the word vaccination or vaccinated	679	287	42·2
"Vaccinated in infancy," no description of vacc. marks ...	788	91	11·5
Do. "no marks," very abundant small-pox eruption	35	13	37·1
Do. "one" vacc. mark	30	3	10·0
Do. two do.	100	10	10·0
Do. three do.	141	13	9·2
Do *4, 5, 6, 7 and 8 vacc. marks*	197	13	6·5
Do. (?) v. marks, very abundant eruption	9	4	44·4
Totals	1979	434	21·9

The accepted fatality before Jenner's birth was ... 16 6

There were—	Cases.	Deaths.	
Re-vaccinated cases at Gloucester	173	9	5·2

These had all kinds of v. marks *up to 8 in number*, and some had been *repeatedly* re-vaccinated; one "often" re-vaccinated. If the same energy had been put into a critical proof of the vaccination of each one as was into avoiding condemning vaccination, there would be little to show, even in fatality, in the above *for* vaccination; as it is, it kills *every* vaccine dogma.

Alex. Wheeler.

Mr. Wheeler, it must be assumed, is wishful to prove that the fatality amongst the vaccinated is as high, or at any rate is not lower than amongst the non-vaccinated. It is surely not necessary for him to separate vaccinated cases into those "with marks" and those with "no marks," since to him it should be immaterial whether a patient be vaccinated or not.

Taking Mr. Wheeler's own classification, we find that of the unvaccinated cases, 679 in number, 287 died, giving a percentage mortality of 42·2; whilst of the vaccinated cases, 1300 in number, only 147, or 11·3 per cent., died. These figures should surely be enough to settle the question as regards percentage mortality, and the mere inclusion of the 21 cases and 10 deaths, whose description includes the word "vaccination" or "vaccinated," does not in any way invalidate the general conclusions to be drawn from these figures.

If now, however, a class for the "under-vaccinated" be included, the second class may be divided into "under-vaccinated" 89 cases with 27 deaths, or 30·3 per cent., and vaccinated 1211 with 120 deaths, giving a mortality of only 9·9 per cent. It is evident that Mr. Wheeler's table in no way conflicts with the figures given in the Report (except in one small particular, noted below), but is based on a misconception of the term "under-vaccination" as used by Dr. Coupland, who used the term to signify those cases of small-pox which had undergone vaccination at any time within the (generally accepted) period of incubation: *i.e.* fourteen days before the appearance of the rash. In the list of "unvaccinated" cases are included a few which were actually vaccinated in the invasion period. No doubt some of these should be placed in the vaccinated class; but others, again, should be grouped in the unvaccinated class. The Royal Commission reckoned the whole group, instead of a large proportion, in this latter class, which is perhaps not strictly scientific and accurate. Mr. Wheeler, however, goes far further astray in including them all in the vaccinated class, which is clearly erroneous. It may be pointed out in this connection that, in his recently published work, Dr. Cory gives some most interesting facts which tend to show that vaccinal immunity is not obtained until nine days have elapsed after inoculation. It would be easy, therefore, from the table on page 149 of the Report, to divide the total 89, there reckoned as "under vaccination," into two sections: (*a*) those vaccinated before, and (*b*) those vaccinated within eight days, of manifesting small-pox. If this were done, there would be added (*a*) to the

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